Miniature Gas Tank

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Porous networks of organic Van der Waals crystals can selectively store methane and carbon dioxide

Washing powders are generally known to consist partially of inorganic zeolites. These aluminosilicates form porous structures whose cavities can act as storage for ions and molecules. In washing powders, they bind the calcium and magnesium ions that cause water to be hard. Largely unknown, however, are organic zeolites, which are also highly promising for applications such as the storage, separation, and purification of gases.

Italian researchers have now investigated such a material down to the finest detail. P. Sozzani and his co-workers from the University of Milan have confirmed the properties of crystals of the organic compound tris-o-phenylene-dioxycyclotriphosphazine. These nanoporous networks are not held together by interactions between positively and negatively charged ions like inorganic salts, but rather by much weaker Van der Waals forces.

Gases such as methane and carbon dioxide can fit into the 4.6Å wide channels in this type of open-pored, layered structure. Once in the channels, the gas molecules come into contact with the aromatic rings of the crystal by means of more Van der Waals interactions. At pressures up to 600 Torr and low temperatures of -78 °C, up to 60 % of the binding sites in the crystal are occupied by methane, and up to 100 % by carbon dioxide. At 25 °C about 15 % of the binding sites remain occupied with methane, and about 40 % with carbon dioxide.

Other gas molecules, such as hydrogen, nitrogen, oxygen, and argon cannot get into the network or are not bound by it. This high selectivity is one of the most interesting properties of the material; in this way, hydrogen could be freed from contamination by residual carbon dioxide and methane, for example. Such highly pure hydrogen is required for hydrogen-powered motors. Other applications, such as the removal of carbon dioxide from air or the storage of fuels are also conceivable.

Source: University of Milan